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PCT/US2004/018413
Docket No.: 03-19 US

Substitute Pages

WHAT IS CLAIMED IS:

1. Apparatus for leak detection comprising:

a first sealable chamber configured to receive a test piece containing a trace gas;

a second sealable chamber;

5 a first valve coupled between the first and second chambers;

a leak detector having a test port, the leak detector comprising an ion pump;

a trace gas permeable member coupled between the second chamber and the test port of the leak detector, the trace gas permeable member allowing the trace gas to pass and blocking other gases, liquids and particles;

10 a vacuum pump having an inlet; and

a second valve coupled between the second chamber and the inlet of the vacuum pump.

2. Apparatus as defined in claim 1, wherein the permeable member is permeable to helium.

15 3. Apparatus as defined in claim 1, wherein the permeable member comprises a quartz member, the apparatus further comprising a heating element in thermal contact with the quartz member and a controller configured to control the heating element.

4. Apparatus for leak detection comprising:

20 a first sealable chamber configured to receive a test piece containing a trace gas;

a second sealable chamber;

a first valve coupled between the first and second chambers;

a leak detector including a test port and a vacuum pump;

25 a second valve coupled between the second chamber and the test port of the leak detector; and

a trace gas permeable member coupled in parallel with the second valve between the second chamber and the test port of the leak detector, the trace gas permeable member allowing the trace gas to pass and blocking other gases, liquids and particles.

30 5. Apparatus as defined in claim 4, wherein the second valve is closed at relatively high pressures in the second chamber and wherein the second valve is open at relatively low

pressures in the second chamber

WO 2004/111598

PCT/US2004/018413
Docket No.: 03-19 US

Substitute Pages

6. Apparatus as defined in claim 4, wherein the permeable member comprises a quartz member, the apparatus further comprising a heating element in thermal contact with the quartz member and a controller configured to control the heating element.

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7. Apparatus as defined in claim 4, wherein a trace gas permeability of the permeable member is controllable.

8. Apparatus as defined in claim 4, wherein the permeable member is permeable to helium.

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9. A method for leak detection, comprising:
providing a first sealable chamber, a second sealable chamber and a first valve coupled between the first and second chambers;
placing a test piece containing a trace gas in the first chamber with the first valve closed;
vacuum pumping the second chamber with the first valve closed;
opening the first valve, wherein gas in the first chamber expands into the second chamber;

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providing a trace gas permeable member coupled to the second chamber, the trace gas permeable member allowing the trace gas to pass and blocking other gases, liquids and particles;
and

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detecting a leak in the test piece by sensing the trace gas that passed through the permeable member with an ion pump and monitoring ion pump current.

10. The method as defined in claim 9, further comprising vacuum pumping the second chamber with the first valve open, and sensing the trace gas pumped from the second chamber to provide detection of small leaks.

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11. The method as defined in claim 10, further comprising controlling the permeable member at a high trace gas permeability at relatively high pressures in the second chamber and controlling the permeable member at a low trace gas permeability at relatively low pressures in the second chamber.

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WO 2004/111598

PCT/US2004/018413
Docket No.: 03-19 US

Substitute Pages

12. The method as defined in claim 11, wherein controlling the permeable member comprises heating the permeable member.

13. Apparatus for leak detection comprising:

5 a first sealable chamber configured to receive a test piece containing a trace gas;

a second sealable chamber;

a first valve coupled between the first and second chambers;

a first leak detector including a test port and a vacuum pump;

a second valve coupled between the second chamber and the test port of the first leak

10 detector;

a second leak detector having a test port, the second leak detector comprising an ion pump; and

a trace gas permeable member coupled between the second chamber and the test port of the second leak detector, the trace gas permeable member allowing the trace gas to pass and

15 blocking other gases, liquids and particles.

14. Apparatus as defined in claim 13, wherein the second valve is closed at relatively high pressures in the second chamber and wherein said second valve is open at relatively low pressures in the second chamber.

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15. Apparatus as defined in claim 13, wherein the permeable member comprises a quartz member, the apparatus further comprising a heating element in thermal contact with the quartz member and a controller configured to control the heating element.

25 16. Apparatus as defined in claim 13, wherein the trace gas permeability of the permeable member is controllable.

17. Apparatus as defined in claim 13, wherein the permeable member is permeable to helium.

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